CHAPTER 10
Data Interpretation Chapter

What is Normal?

In the beginning it will take you some time to know what is normal for your site and during this time it is especially important to collect data regularly to accurately characterize your site. Eventually you will know what to expect for the water quality of your site. You will also get an idea of how your site reacts to various conditions discussed below including land use, precipitation, season, and time of day. After you determine what is normal for your individual site, you may want to know if your site is normal when compared to other sites across the state. You might try to compare your site to other similar sites or compare sites above and below a potential pollution source to see if your site is impacted. This chapter will help you understand the data that you collect.

How often should you collect data?

This is a question that many volunteers ask themselves. Information about your site will only become apparent after you have collected data over a period of time under a variety of conditions. There is not a lot of data (or any in some cases) for most of the streams in Iowa. This is why you, the citizen monitor, are of vital importance in maintaining and improving our state's water quality. The more data that you collect, the more you will learn about the water quality of your waterbody. However collecting data more frequently requires a bigger investment of time for volunteers. At a minimum, IOWATER recommends that you collect samples monthly during the open water season.

Sampling a site just one time will give you a snapshot of water quality at that time, but depending on the conditions when you sample, the data you collect might not be representative of normal conditions at your site. If instead you collect samples monthly, you will get a broader picture of water quality at your site. You will have data from a variety of conditions: multiple seasons, dry weather and wet weather, cold and hot weather, influences from various land uses in the watershed, activities that may occur throughout the year, etc. In general, you will get a more complete picture of overall water quality at your site with increased sampling frequency. Sampling more frequently than monthly will further refine your picture of water quality at your site by allowing you to sample under a greater variety of conditions.

Sampling a site over a multi-year period gives you a better idea of the overall water quality at your site and allows you to see how your site has changed over time. After collecting multiple years of data, the results can be graphed and can show whether a certain parameter is increasing, decreasing, or staying the same. Figure 1 shows that transparency at the Montgomery Creek 1 Site shows a decreasing trend (transparency is getting worse) from 2001 through 2009. Figure 2 shows the nitrate trend for the same site is also decreasing (nitrate values are improving).

Figure 1. Transparency Trend at Montgomery Creek 1, Boone County
(Snapshot Site SC8, IOWATER Site 908019).

(NOTE: The black line in the following graphs represents the trend line using linear regression. The trend line shows whether the values for each parameter have increased, decreased, or stayed relatively the same. The trend lines below are not considered statistically significant; however, visual inspection can show changes in these parameters over time.)

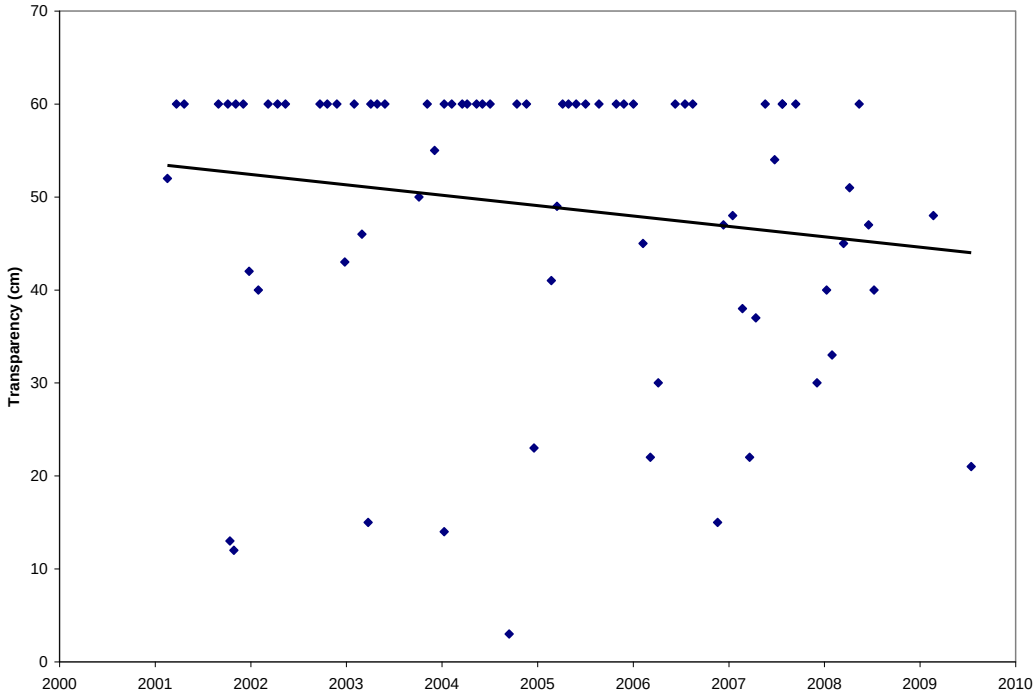
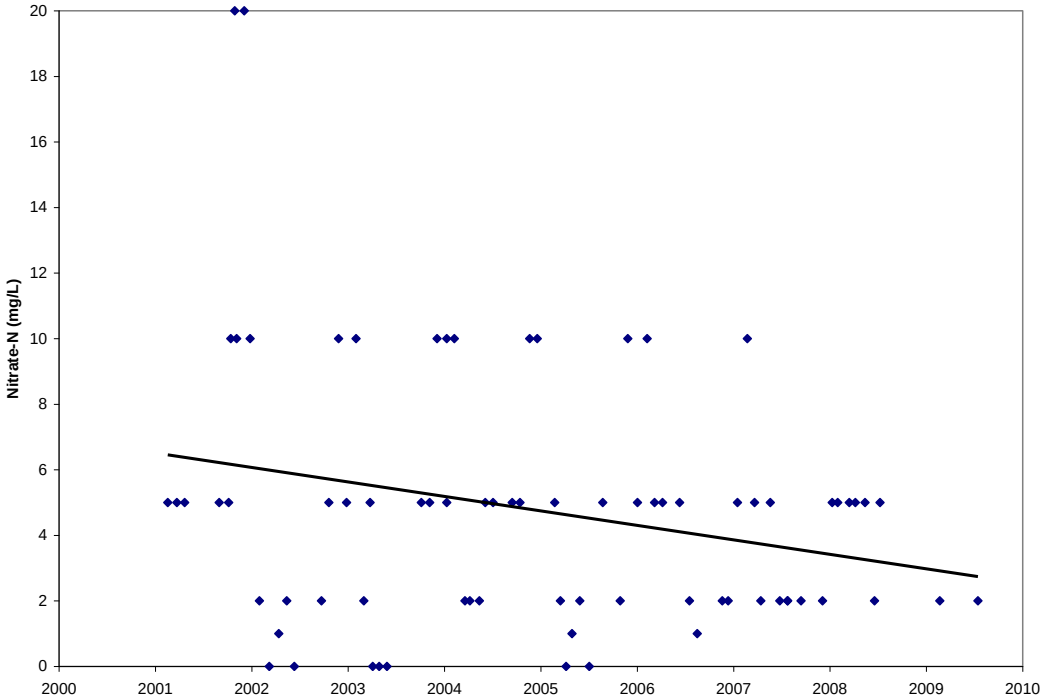
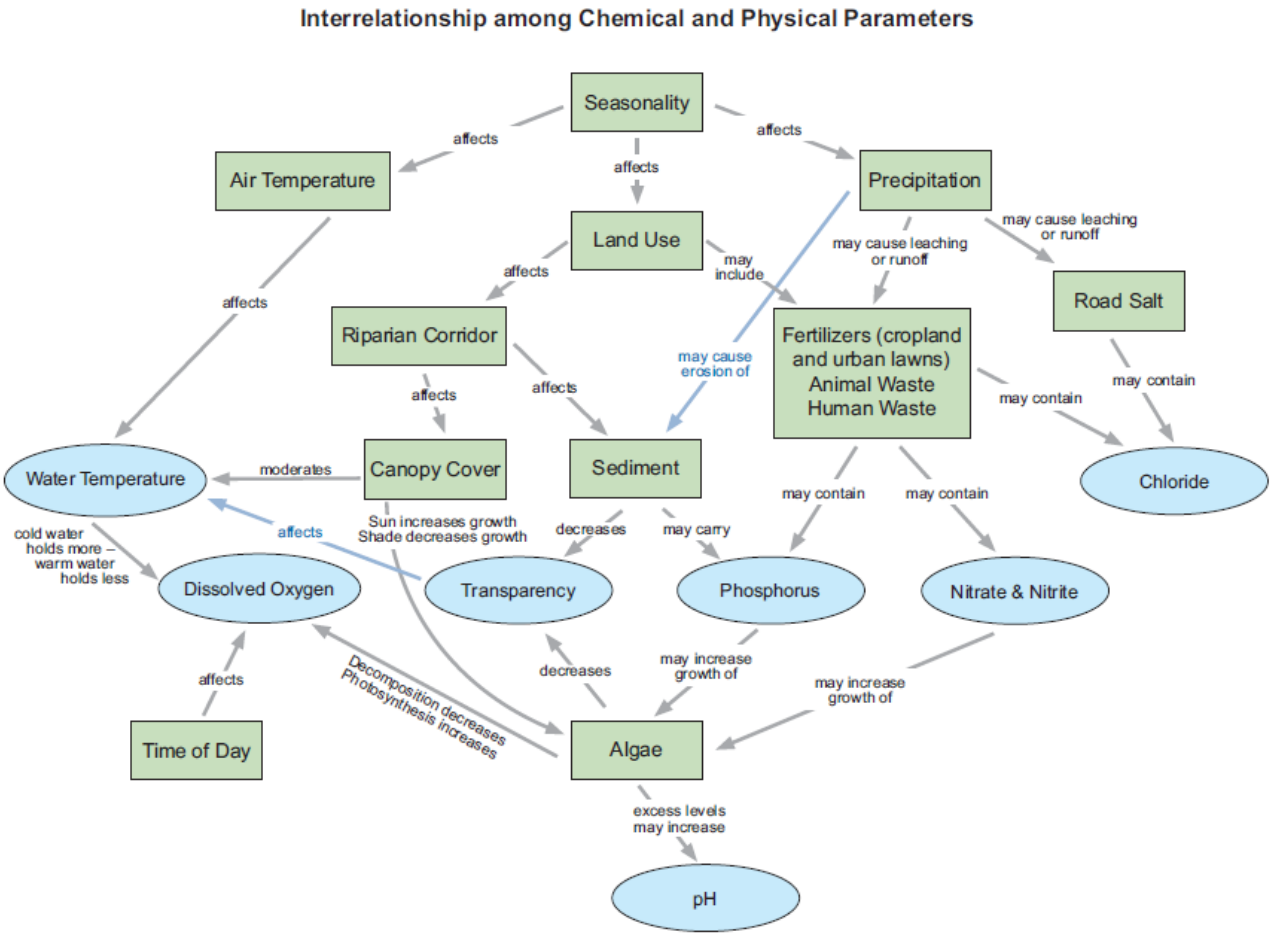


Figure 2. Nitrate Trend at Montgomery Creek 1, Boone County
(Snapshot Site SC8, IOWATER Site 908019).



Water Quality Parameters are Connected

Aquatic chemistry is complex and is influenced by many interrelated factors. The results that you get are one piece of a complex web of interactions that includes inputs from the watershed, physical factors at the time you sample, such as weather, and the chemistry of your water body. The diagram below illustrates the complexity of these interactions.



Land Use and Water Quality

In Iowa, almost all of our land has been developed for agricultural, commercial, or residential purposes. In Iowa, 98% of the land is in private ownership. The private ownership of land, different land uses, and different land types across the state all have implications for water quality of rivers, streams, lakes, and ponds. The land use directly surrounding and in the watershed of your sampling site can have a significant effect on the water quality at your site. For example, streams and lakes with mainly corn and soybean fields in their watershed tend to have higher levels of nutrients (nitrogen and phosphorus) than waterbodies surrounded by forests or prairies. Streams within cities, or those that have cities in their watershed, tend to have higher levels of chloride in their water. While, the majority of Iowa's landscape is used for the production of corn and soybeans, notable exceptions include the northeast corner of the state that is dominated by rugged topography and bedrock outcrops, the pasturelands of southern Iowa, and some areas of the Loess Hills along Iowa's western border. Below are some general characteristics of streams and lakes in different areas of the state. It is important to remember,

however, that each waterbody is unique and that these are only general trends seen when comparing different areas of the state.

Northeast Iowa

The northeastern portion of the state is characterized by rugged topography and bedrock outcrops. The area has many spring-fed streams that maintain cool water temperatures year round. The land uses in this area include forest, pasture, and row crop. In general, water quality tends to be slightly better in this area of the state with lower levels of suspended sediment in the water (i.e., higher transparency) and low to moderate levels of nitrogen and phosphorus.

North-Central Iowa

The north-central part of the state is characterized by flat topography. Land use in this area is dominated by row crop. This area is also characterized by large tile drainage systems that make the area suitable for row crop agriculture. Most of the natural lakes in Iowa are located in this region. In general, water quality in this region is variable. Nitrogen and phosphorus levels tend to be high, while suspended sediment can be moderate to high (lower transparency). The natural lakes in this region are mainly shallow systems with the exception of West Okoboji Lake, which is extremely deep. The water quality in these lakes varies from clear, low nutrient water like that in West Okoboji Lake to turbid, nutrient-rich water that is characteristic of the more common shallow natural lakes of this region.

Western Iowa

The western portion of the state is best known for the Loess Hills and rolling irregular plains. Land use in this area is mainly cropland with forests and grassland on the hills. The soil in this portion of the state tends to be highly erodible. In general, water quality in this area tends to be poor to moderate. This area has the highest levels of suspended sediment (i.e., low transparency) in the state and also has relatively high nitrogen levels.

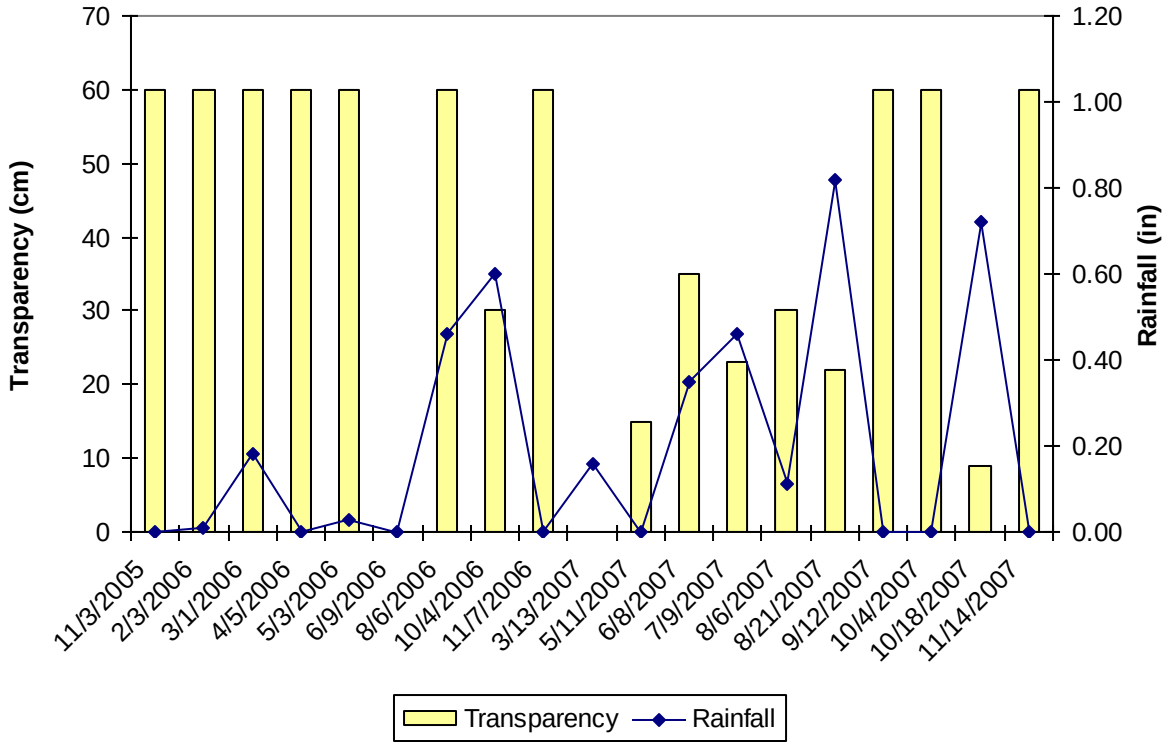
Southern Iowa

The southern portion of the state is characterized by irregular plains and open low hills. Land use in this area consists of a mix of forest, pasture, and row crop. In general, water quality in this area tends to vary depending on the parameter. Suspended sediment tends to be moderate, while nitrogen levels tend to be low.

Precipitation and Water Quality

Some parameters are sensitive to rain. Rain can cause dramatic changes in chemical levels. Changes in water quality after rain events are important to document and can tell you about your site's overall water quality, but are not generally a cause for an "emergency response." Rain can also tell you something about the source of pollution to your site. If your tests show higher levels of contaminants after rainfall, it tends to indicate that those contaminants are coming from non-point sources. If your tests show higher levels of contaminants at low flow (during dry times), it tends to indicate that the contaminants are related to point sources.

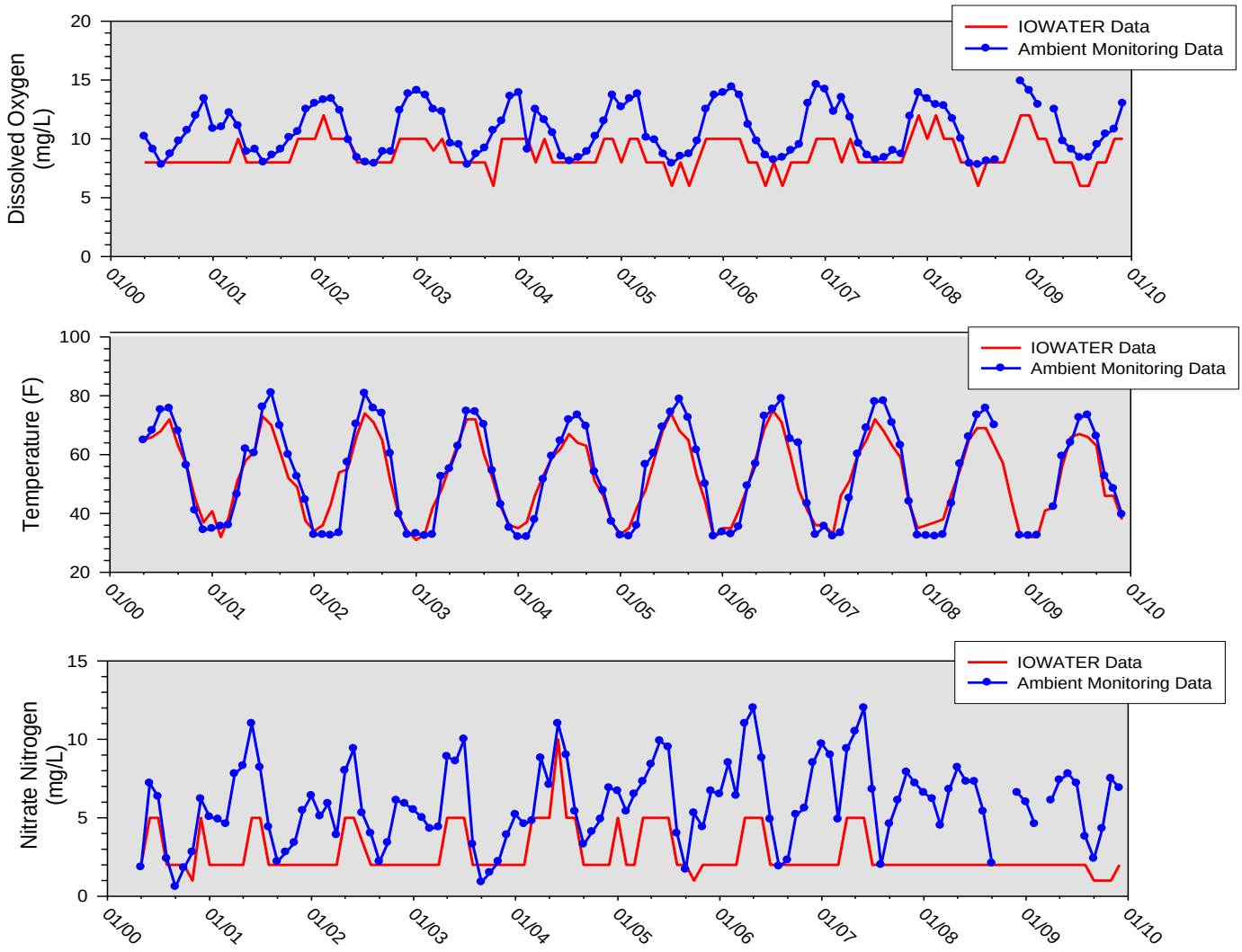
Figure 3. Transparency and Rainfall at the Highway 7 Bridge Site on Powell Creek (Site Number 911021; Buena Vista County).



Seasonal Shifts in Water Quality

Many parameters will exhibit seasonal shifts. For example, water temperatures in many streams generally increase through the summer and decrease again in the fall. At the same time, dissolved oxygen concentrations tend to decrease through the summer and increase in the winter in Iowa's streams and rivers because cold water is able to hold more oxygen than warmer water. Nitrate and nitrite levels are generally higher in the spring when fertilizer is applied and rainfall is greater. Figure 4 shows the changes in temperature, dissolved oxygen, and nitrate nitrogen each year from 2000 through 2009. Illustrated in Figure 4 are the median values for IOWATER collected data, as well as ambient monitoring data collected by the Iowa DNR from a network of 75 to 84 streams statewide that are monitored monthly.

Figure 4. IOWATER Data and Ambient River and Stream Monitoring Data 2000-2009.

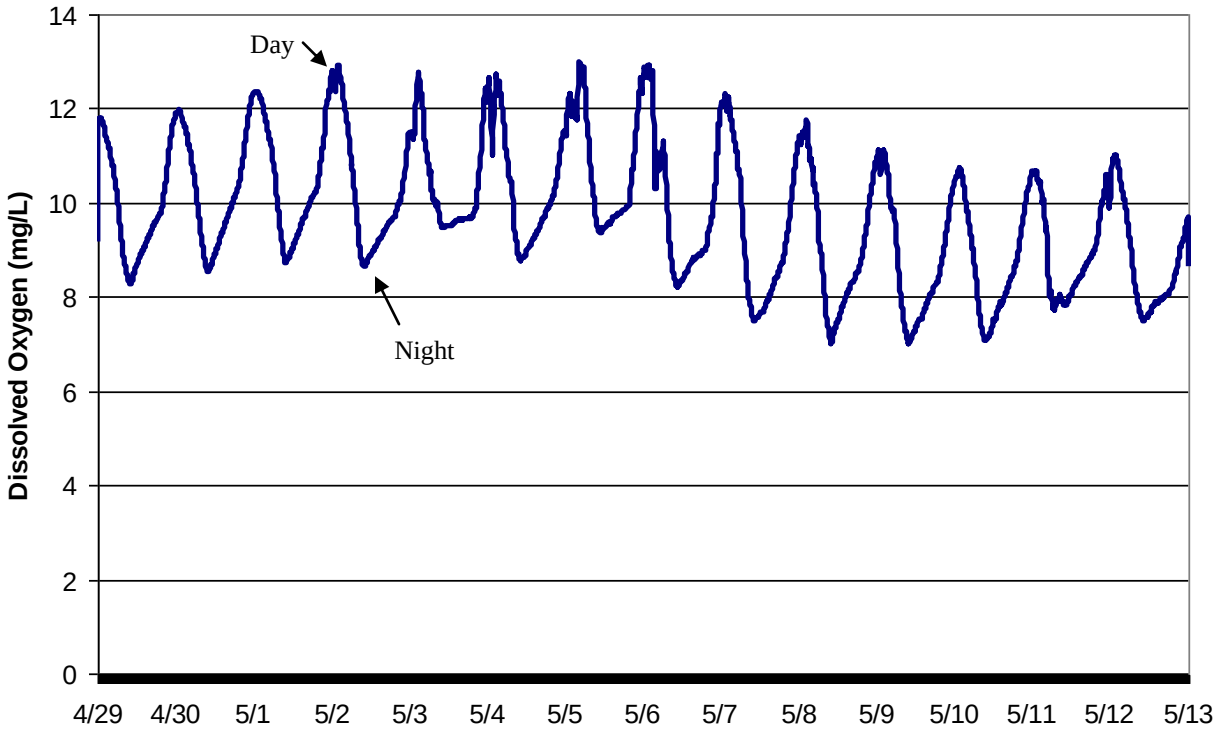


Daily Shifts in Water Quality

Some parameters even change depending on what time of day you measure them. For example temperature begins to increase when the sun comes up with the highest temperature generally occurring in mid to late afternoon. The temperature then falls after sunset.

Dissolved oxygen also is affected by the time of day. Dissolved oxygen levels are highest during the day when the sun is out. Dissolved oxygen increases during the day because plants and algae begin the process of photosynthesis which creates oxygen. When the sun goes down, the plants and algae don't have that energy source and stop doing photosynthesis. However, they continue to use oxygen, which leads to a net loss of oxygen in the water. Furthermore, bacteria in the water continue to break down dead plant and animal matter, consuming some of the oxygen found dissolved in the water. This can cause large swings in dissolved oxygen over the course of a day. As shown in Figure 5, it is not uncommon for dissolved oxygen to shift 4 mg/L or more during a 24 hour period.

Figure 5. Dissolved Oxygen Concentrations at Hecker Creek, Allamakee County, Iowa April 30 through May 14, 2007.



Physical Influences on Water Quality

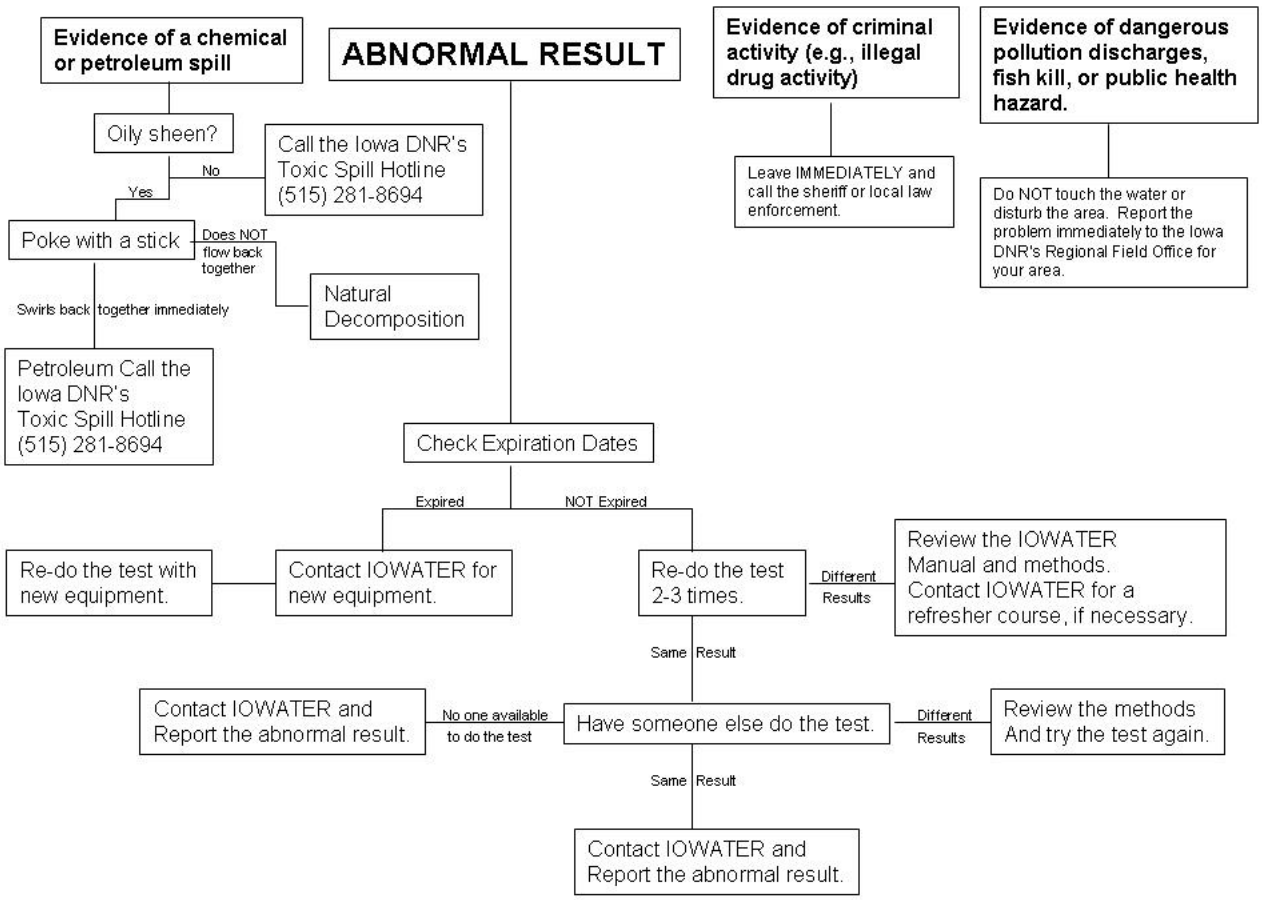
When trees are removed from stream, river, or lake banks the amount of shading or canopy cover in the riparian zone decreases, allowing more sunlight to reach the stream, river, or lake. This causes the water to warm, which can decrease dissolved oxygen levels. Removing canopy cover also reduces the amount of habitat available in water bodies.

Abnormal Results

As you probably realize by this point, water quality is affected by many variables and can be challenging to interpret. As a citizen monitor, you may measure a water quality parameter value

that is unusual or exceeds water quality criteria. There are many factors that determine whether there is a water quality problem or if a water quality violation has occurred. Always consider contacting IOWATER if you think you have abnormal results. Included in this section is a flow chart of steps to take when you think you have an abnormal result. While the values below might not be abnormal for your site, they are some guidelines as to what could be considered abnormal for each of the chemical/physical parameters:

- Nitrite values of 0.3 or greater (0.3, 1.0, 1.5, & 3.0 mg/L)
- Nitrate values of 20 or greater (20 or 50 mg/L)
- Phosphate values of 0.6 or greater (0.6, 0.8, 1.0-8.0, 10 mg/L)
- Dissolved Oxygen values of 5 or less (1-5 mg/L)
- pH values of 6 or less (4, 5, 6)
- Chloride values of 100 or greater (100 - >600 mg/L) – ">" means "greater than"



Please remember that if there is evidence of a criminal activity (i.e., illegal drug activity) that is immediately dangerous to leave IMMEDIATELY and call the sheriff or local law enforcement. If there is evidence of dangerous pollution discharges, fish kills, or public health hazards, report immediately to the Iowa DNR's Environmental Services Division Field Office for your area (see last page of the manual for contact information). Be sure to document the location and visual information about the problem, but do not disturb the area. If there is evidence of chemical or petroleum inputs and the input could result in an immediate hazard, call the Iowa DNR's Toxic Spill Hotline at (515) 281-8694. If an oily sheen is present, you can determine if the sheen is a natural occurrence by simply poking the sheen with a stick. If the sheen swirls back together

immediately, it's petroleum. If the sheen breaks apart and does not flow back together, it is from bacteria or plant or animal decomposition. REMEMBER: If you have any questions, please contact IOWATER for assistance.

The Power of Volunteers

After some time monitoring your site, you may begin to wonder why you continue to monitor every month/week/day. Has your monitoring helped to improve water quality and/or helped further your understanding of water quality at your site? The case studies below illustrate a few examples of why it is important to monitor consistently and over a long period of time. These volunteers have helped solve water quality problems in their communities, but it's important to note that in neither case did volunteers set out to identify and solve problems – they simply wanted to gain a better understanding of the aquatic resources that were important to them. In both cases, however, continued and persistent monitoring was vital to water quality protection and improvement.

Squaw Creek, Story County

IOWATER volunteer Erv Klaas has been doing monthly monitoring at two sites on Squaw Creek in Ames, IA for IOWATER chemical/physical parameters since November 2001. The two sites are located about 1.5 miles apart. At the downstream site, a storm drain discharges to Squaw Creek just upstream of where the stream is monitored.

In early 2004, Erv added *E. coli* bacteria monitoring to his monitoring. After 6 years or *E. coli* monitoring Erv had a good understanding of what was normal for his sites. So, when he sampled in September of 2009, he knew something was different with the downstream site. When he poured his water sample onto the three downstream bacteria plates, they would not solidify and turned a solid dark color. The plates from the upstream site, however, solidified and reacted similarly to past samples from that site.

Concerned about these results, Erv contacted IOWATER staff to tell them about the strange bacteria samples from the downstream sites. IOWATER staff had never seen bacteria plates react like this before so they contacted the maker of the bacteria plates, Micrology Laboratories. Micrology Laboratories requested that Erv send in the downstream plates for further investigation and determined that the samples submitted by Erv were heavily contaminated with fecal contamination. Staff at the laboratories subsequently determined that *E. coli* levels approached 9 million Colony Forming Units/100 milliliters (CFU/100 ml). The E. coli bacteria water quality standard for Iowa's surface waters is 235 CFU/100 ml.

Staff at the City of Ames Public Works Department were then contacted and informed of the elevated *E. coli* bacteria at the downstream site. Erv shared the results of his monthly monitoring at both sites to show the City of Ames staff that this was a highly unusual result for this site. The City of Ames staff agreed and investigated the storm pipe upstream of the site. The Ames crew found sewer odors in the stormwater pipe and decided to do dye testing and use a camera to investigate the storm sewer line and the sanitary sewer line that sits above the storm line. A crack and hole was found in the sanitary sewer line and sewage was leaking into the storm line and discharging to Squaw Creek just above Erv's sampling location.

The City of Ames repaired both the storm and sanitary lines, and Erv has since been out and sampled both sites and bacteria levels at the downstream site have returned to more typical

levels. If Erv had not been monitoring this site regularly, this problem may have gone undetected. Erv's regular monitoring and knowledge of normal conditions for his site, coupled with the City of Ames' willingness to investigate and address this issue allowed this problem to be fixed.

"The IOWATER Program is a great tool which helps us to identify this type of problem." - Ames Public Works Department Staff.

Clear Creek, Johnson and Iowa Counties

The story of Clear Creek began in 2003 when IOWATER volunteer Dave Ratliff of the Johnson and Iowa County Watershed Coalition organized the first snapshot event of streams in the two counties. Clear Creek begins in Iowa County and continues east into Johnson County where it empties into the Iowa River in Coralville and was sampled as part of this snapshot event.

Results from the September 2003 snapshot indicated elevated chloride levels (>600 mg/L – the average chloride concentration for Iowa streams is 23 mg/L) at the farthest upstream site on Clear Creek. Because the results were abnormal, the site was re-sampled on the same day and the high value was confirmed.

In the months following the September 2003 snapshot, 5 tile lines were located one mile upstream from the site with the high results. Three tile lines were located in a north junction box; two additional tile lines were located in a south junction box. These sites were sampled in January 2004 and it was found that the south junction box was the primary source of the high chloride levels.

Determined to get to the source of the high chloride values, Dave Ratliff discovered that the tile line that fed the south junction box began near a Department of Transportation (DOT) facility. A pile of sand mixed with salt used on roads during the winter was stored outdoors and was slowly leaching into the tile line. Dave alerted the DOT to the water quality concern. In response, the DOT staff built a storage structure to enclose the sand pile and reduce leaching.

The Clear Creek story, however, doesn't end there. The Johnson and Iowa County Snapshot continued in May 2004 with the inclusion of both the north and the south tile junction boxes. Volunteers who sampled the north junction box that day noted what appeared to be toilet paper coming out of the north tile line along with a slight sewage odor. The IOWATER test kit results from that site, however, did not differ much from the other tile lines that were sampled.

In July 2004, the Clear Creek headwater sites were sampled again as part of a snapshot. Again toilet paper fragments, sewage odor and this time elevated chloride levels were noted at the north junction box. In August 2004, the Iowa County Health Department and DNR Field Office were contacted about the water quality concern. During the next few months volunteers continued to document the problem through water testing and pictures at these tile lines.

In January 2005, Don Lund and Dave Ratliff designed and installed a trap at the outlet of the north tile line. Within 24 hours the trap was 100% coated with sewer sludge, toilet paper, and feces. Photographs of the trap were shown to IOWATER staff and sent to the DNR Field Office. These photographs provided substantial evidence of the problem and in January 2005, the Iowa

County Board of Health was informed by the Iowa DNR that they would be receiving a Notice of Violation concerning the problem and would be required to address it.

The community of Conroy is near the north tile box. It was found that several septic systems in that community were connected to, and illegally discharging into the north tile line. Plans were developed to construct a centralized wastewater treatment system to replace the individual septic systems in Conroy. In December 2008 the wastewater treatment system was completed.

The story of Clear Creek and Conroy can be considered a success, not only because it fixed a long-term problem in that location, but also brought statewide attention to the issue of failing or illegally discharging septic systems in Iowa. On July 1, 2009, a new law was implemented that now requires pre-sale inspections for buildings with septic tanks. It is hoped that the new inspections at the time of property transfer will help eliminate the estimated more than 100,000 substandard septic systems in Iowa.